

Surface analogy and spelling rules in English vowel alternations

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Abstract

Previous psycholinguistic research into the English vocalic system suggest that the vowel alternations [e^j~æ, i^j~ɪ, a^j~ɪ, o^w~a, u^w~ʊ], termed spelling rule alternations, are psychologically significant for English speakers, in that they can influence the pronunciation of unfamiliar words. In this paper, the influence of these salient alternations on nonce words and neologisms is assessed. The effect of surface analogy on the pronunciation of novel words is also examined. Surface analogy may be defined as the influence exerted by the fully specified surface forms of the morphemic relatives of a word. It assumes that all allomorphs of a given morpheme have individual representation in the mental lexicon.

An experiment was performed in which the subjects' task was to determine the pronunciation of a nonce word or neologism when it was combined with a derivational suffix to form a new word. The potential pronunciations of the new words differed in the vowels they contained. A response which contained the same vowel as the test word was a choice in all test items. Other potential responses contained vowels consistent with the spelling rules, vowels predicted by surface analogy, and vowels predicted by neither. The results indicate that the responses were influenced, both by the spelling rule alternations, and by the vowels in the morphemic relatives of the test words. However, the spelling rule alternations exerted more influence than did the morphemic relatives.

Key Words: English vowel shift, analogy, morphophonemics.

0. Introduction. Vowel alternations in English have been of great interest to phonologists, especially within the generative paradigm. The abstract nature of the underlying representations posited by Chomsky and Halle (1968), Halle (1977), and Halle and Mohanan (1985) to account for the present-day vowel alternations resulting from the Great Vowel Shift prompted a number of researchers to devise experiments to test the psychological validity of these alternations (Cena, 1978; Jaeger, 1984, 1986; Moskowitz, 1973; Myerson, 1976; Ohala, 1974; Steinberg and Krohn, 1975; Templeton, 1979; Wang, 1985; Wang and Derwing, 1986, 1994). The consensus that has emerged from these studies is that only five of the alternations resulting from the Great Vowel Shift are psychologically significant for contemporary English speakers, namely [e^l~æ, i^l~ɪ, a^l~ɪ, o^w~a, u^w~ʊ]. That is to say, these alternations, in contrast to others, were found to play a significant role in experiments involving concept formation, learning, memory, and pronunciation preference. In addition, they are the most consistent orthographic to vowel sound correspondences in English. As a result of these studies, Jaeger (1986), and Wang and Derwing (1986) suggest that the psychological basis for these vowel alternations stems from English spelling rules. That is to say, what these five alternations have in common is that each one represents what are often taught in grammar school as the 'long' and 'short' versions of the five written vowels in English. For example, the grapheme <a> has two common pronunciations 'long'[e^l] and 'short'[æ].¹ The existence of [æ] in one word often implies the existence of [e^l] in a morphemic relative (e.g. *sane*, *sanity*).

Of course, it may be that these alternations are psychologically significant for illiterate English speakers as well, in which case, the spelling rule hypothesis would not be sustainable. English speakers may come to relate the vowels in these alternations long before, or in the

absence of formal schooling. The large number of related words which demonstrate spelling rule alternations (*derive~derivative, grave~gravity*) may be sufficient to make these pairs of vowels psychologically salient, and allow them to be applied to novel words. The studies cited above were not designed to demonstrate that explicit training in English sound to grapheme correspondences is responsible for establishing a perceived relationship between the vowel alternations [e^j~æ, i^j~ɪ, a^j~ɪ, o^w~a, u^w~ʊ]. What they do show is that these five alternations are psychologically relevant for English speakers, in contrast to several other vowel alternations discussed in the linguistic literature (e.g. [u^w]~[a], *lose~lost*).

The five alternations, whose psychological significance finds support in the literature, will be referred to as spelling rule alternations throughout the remainder of this paper, in order to distinguish them from other vowel alternations that will be discussed. I remain neutral as to the role orthographic instruction has on making these alternations psychologically salient. The principal purpose of this paper is to demonstrate that spelling rule alternations play a significant role in determining the pronunciation of novel words. In addition, surface-form analogy will be introduced as another important factor that governs English vowel alternations. Surface analogy may be defined as the influence exerted by the fully specified surface forms of the morphemic relatives of a word. It assumes that all allomorphs of a given morpheme have individual representation in the mental lexicon, and are not derived from underlying forms. Not only does surface analogy play a part in the five spelling rule alternations, but in other alternations as well. Evidence to this effect was found by means of an experiment involving neologisms and nonce words.

1. Ruleless models. In recent years, models which explain phonological and morphological alternations by means of underlying representations and rule systems are receiving more and more competition from models that involve no rules (e.g. Bybee, 1985, 1988, 1995; Rumelhart and McClelland, 1986;² Stemberger, 1985, 1994; Skousen, 1989, 1992). The idea that all, or at least most, mono- and multimorphemic words have individual, fully-specified, representation in the mental lexicon is central to many of these ruleless models, and is supported by a great deal of empirical evidence (Aitchison, 1994; Alegre and Gordon, 1999; Aske, 1990; Baayen, Dijkstra, and Schreuder, 1997; Butterworth, 1983; Bybee, 1995; Derwing, 1990; Eddington, 2000; Manelis and Tharp, 1977; Marchman, 1997; Nakisa, Plunkett, and Hahn, 1998; Ohala and Ohala, 1986; Seidenberg, 1992; Seidenberg and Bruck, 1990; Sereno and Jongman, 1997; Stemberger and MacWhinney, 1988). However, the notion of fully-specified representation is far from uncontroversial, and there is also evidence that some multimorphemic words may be composed on-line (e.g. Clahsen et al., 1992; Marcus, 1995; Pinker, 1991, 1997; Pinker and Prince, 1994; Ullman, 1999).

The notion that individual word tokens are stored in their surface phonetic form is supported by psycholinguistic evidence as well (Bybee, 1994; Goldinger, 1997; Palmeri, Goldinger, and Pisoni, 1993; Pisoni, 1997). In fact, storage of surface forms may go beyond individual words and encompass recurrent word combinations as well as entire phrases (Bod, 1998; Bybee, 1999; Pawley and Syder, 1983). In essence, many of the central elements of generative phonological theory, such as underlying representations, derivational rules, and the cycle are unnecessary in a model that relates fully specified surface forms to each other, instead of to more abstract underlying forms (Burzio, 1996). In addition, there is also growing doubt as

to the adequacy of these mechanisms from a theoretical standpoint (Cole, 1995; Cole and Hualde, 1998; Steriade, 1995).

Of course, even a ruleless model of language must be able to explain how new and previously unseen words are produced and understood. Nevertheless, it is possible to explain the productive aspect of language without recourse to overly abstract underlying forms. Skousen's (1989, 1992) analogical model seems particularly promising in this regard. In any event, if fully specified storage of most words is a reality, it follows that the surface forms themselves can influence the production of new words. In the process of word formation, the influence exerted by the surface forms of the morphemic relatives of a word will be referred to as Surface Analogy. Surface Analogy bears some resemblance to a number of recent proposals.

2.0 Constraints invoking surface analogy.

2.1. Lexical conservatism. In phonology, lexical conservatism may be defined as the tendency to avoid producing allomorphs whose phonological shape is novel and unattested. According to Steriade (1997:1):

Phonological processes are, under certain circumstances, blocked from creating novel phonological variants to a listed stem. Rather than generating new allomorphs, speakers recycle already existing ones, when none of the listed allomorphs gives full satisfaction to the applicable phonological and morphosyntactic conditions.³

An example of lexical conservatism is provided by Steriade (1997). She conducted an experiment in which subjects were asked to determine the stress placement in novel adjectives

ending in *-able* that are based on a verbal forms (e.g. *eradicable* from *eradicate*). Most of these adjectives must be considered neologisms, which means that their stress pattern was not merely accessed from the mental lexicon. The results indicate that the stress pattern of the verbal form was shifted to the right in an adjectival form only if stress also falls on that syllable in a morphemic relative. For example, in *govern*, *governor*, *government*, stress always falls on the first syllable. There are no allomorphs with the pattern **govern-*. In cases such as these, the stress on the adjective was not shifted to the right as phonotactic constraints would predict. This yielded adjectives such as *governable*, and not **governable*. On the other hand, many verbs such as *démonstrate* have morphemic relatives with stress falling on the syllable to the right (i.e. *demónstrative*). In these cases, subjects preferred stress that was shifted to the right in the adjectival form, as in *demónstrable*.⁴ According to lexical conservatism, the existence of *demónstrative* allows stress to fall on the second syllable in *demónstrable*, while the lack of any allomorph with **govern-* is responsible for the word initial stress of *governable*.

Of course, the results of Steriade's study may be attributed to a number of other forces besides lexical conservatism. However, a discussion of possible alternative explanations is beyond the scope of the present study. Steriade's study of neologisms is merely cited as an illustration of her conception of lexical conservatism as a constraint in morphophonology.

The notion of surface analogy as used in the present paper differs from Steriade's (1999a) view of lexical conservatism in one important way. Lexical conservatism is essentially a blocking mechanism. If a general phonological process would apply in such a way as to produce an allomorph that is unattested in the language, that process will under certain conditions be blocked by lexical conservatism. Surface Analogy, on the other hand, merely

implies that the phonetic make-up of the existing allomorphs of a base form may influence the production of another allomorph of that base form; the creation of unattested allomorphs is disfavored. Surface Analogy does not entail blocking.

2.2. Transderivational identity constraints. In SPE (Chomsky and Halle 1968), in order for the phonological shape of one word to affect that of a morphemic relative, the notion of cyclicity was employed in which one related word was embedded in another (e.g. [[condense]ation]).

Within the framework of Optimality Theory, the work formerly done by the cycle is carried out by means of a number of constraints which are also transderivational in nature. Many of these are extensions of Correspondence Theory (McCarthy and Prince, 1994a, b). The essence of these constraints is that the output of GEN may be constrained by the surface phonetic form of independently existing words (Benua, 1995; Burzio, 1996; McCarthy, 1995). For example, Kenstowicz (1996) defines Base-Identity in this way: "Given an input structure [X Y] output candidates are evaluated for how well they match [X] and [Y] if the latter occur as independent words." In a similar manner, the Uniform Exponence constraint gives preference to morphological relatives that share surface traits so that paradigms are kept maximally uniform (Kenstowicz, 1998).

It would be possible to consider Surface Analogy as a variant instantiation of a transderivational constraint in Optimality Theory. However, the two influences that will be discussed, Surface Analogy and the alternations embodied in the spelling rules, would not allow one to determine a single unique constraint ranking between the two (e.g. Surface Analogy << Spelling Rule), as the results of the experiment will demonstrate.

3. Surface analogy in studies on the English vowel shift. One of the earliest experimental techniques which was applied to the vowel shift question were morpheme combination experiments. In this type of experiment, the subjects were given an existing word and a suffix and asked to combine them to construct a neologism (Ohala, 1974; Steinberg and Krohn, 1975). For instance, subjects were asked to combine *maze* and the suffix *-ic* to form the word *mazic*. The expected outcome would be [me^ɪz] | [mæzIk]. However, the most common way subjects handled these questions was to leave the vowel unchanged (i.e. [me^ɪz] | [me^ɪzIk]). According to Surface Analogy, this occurs because the use of [mæz-] would entail the creation of a novel allomorph. The unchanged form, on the other hand, is preferred since [me^ɪz-] is the only attested allomorph.

Myerson (1976) performed a similar experiment with nonce words and obtained the same results. The fact that nonce words, such as *tr[e^ɪ]ve*, usually yielded unchanged forms, such as *tr[e^ɪ]vity*, instead of *tr[æ]vity*, can be explained by the fact that the nonce form *tr[e^ɪ]v-* is the only allomorph available to work with. Generating a word such as *tr[æ]vity* entails producing an unattested allomorph in violation of Surface Analogy.

Of course, many experiments did produce results that are consistent with the English Spelling Rule, in violation of Surface Analogy. However, these studies were designed in such a way as to eliminate Surface Analogy as a factor. For example, in another experiment by Myerson (1976) the subjects' task was to choose between two different pronunciations of various nonce words (e.g. *tr[e^ɪ]ve*) that had been affixed with *-ity* and *-ical*. Yet, neither of the two possible responses contained the same vowel as the unaffixed nonce word (e.g. *tr[æ]vity*, *tr[ɛ]vity*). A similar situation exists in Wang and Derwing's (1994) studies. Subjects were

required to choose a response whose vowel differed from that of the base word presented to them. In a study that uses nonce words, the only allomorph available to the subjects is that of the experimental nonce word. Therefore, Surface Analogy predicts that affixation of the nonce word will not result in a derived word with a different vowel. However, Myerson's and Wang and Derwing's subjects did not have the option of leaving the vowel unchanged. Hence, they had to adopt other strategies for determining which vowel to choose. Wang and Derwing suggest that these strategies included using the Spelling Rule and analogizing on existing words.

A number of other experiments were carried out to test the psychological validity of certain vowel shifts. For example, Jaeger (1984), Moskowitz (1973), and Wang and Derwing (1986) carried out experiments which utilized a concept formation technique. Cena's (1978) study involved the learnability of nonce words with different alternations, and Myerson (1976) tested the effect of the alternations on the recall of nonce words that had been memorized. These studies provide valid positive evidence about the psychological validity of the alternations embodied in the Spelling Rule. However, they give no insight into the effect of Surface Analogy on vowel alternations. The experimental paradigms employed simply do not allow for possible production of an existing versus a non-existing allomorph. Therefore, it should be evident these studies do not address, (nor do they intend to address), the effect that Surface Analogy has on vowel alternations.

4. The experiment. The purpose of the present experiment is to determine the effect that the English Spelling Rule and Surface Analogy have on vowel preferences in derived neologisms and nonce words.

4.1. Subjects. Subjects were all undergraduate college students who received extra credit in a course for their participation in the study. All were native speakers of American English.

Twenty-two males and 19 females participated. Ages ranged from 18 to 25 years of age with a median age of 21.

4.2. Procedure. The questionnaire consisted of 63 test items: 21 nonce items and 42 neologisms. The order the items appeared in the questionnaire was determined at random, and each item was presented in the format of a short sentence or paragraph. For example,

"Of course she's beautiful," he thought, but he still couldn't stand her denague attitude. If it weren't for her _____, he had even considered asking her out.

During the experimental session, subjects read along silently as the experimenter read the context paragraph for each item out loud.⁵ Afterwards, the experimenter read the three possible responses, and the subjects marked a letter corresponding to their preferred response. The subjects saw no orthographic representation of the responses. All context paragraphs and responses were read through twice in their entirety. The experimental session lasted about 45 minutes.

Subjects were informed that their task was to choose the response that sounded the most correct to them. They were informed that the word that fit in the blank was related to the underlined word in the paragraph. Given the tendency to respond without changing the root vowel, which was observed in previous experiments (Myerson, 1976; Ohala, 1974; Steinberg and Krohn, 1975), the subjects were told to choose the option with the same vowel sound that the underlined word contained only if the other options were completely unacceptable. These

instructions were given both in writing and orally. It was hoped that by following these instructions, the effects of Surface Analogy as well as those of the Spelling Rule would be manifest.

4.3. Stimulus materials. The 63 test items fall into one of six categories. For the sake of clarity, the categories and the specific questionnaire items in each category are presented in the following section along with the results for each category. Derived forms were made with the addition of the suffixes *-ify*, *-ical*, *-atory*, *-tion*, *-ative*, *-ic*, *ity*, or *-ification*. These suffixes were chosen because they generally ‘trigger’ a change of vowel quality, although the change is not without exceptions (e.g. *obese* ~ *obesity*). In addition, these suffixes were among those used in the previously cited studies on vowel alternations. The order in which the test items and possible responses were presented was randomized in the questionnaire.

4.4. Results and Discussion.

4.4.1. Nonce words with [e^l, i^j, a^l, o^w]. In a previous study (Myerson, 1976), subjects overwhelmingly preferred to leave the vowel of a nonce word unchanged when they combined it with a suffix to form a new word. Surface Analogy suggests that since no other allomorphs exist for nonce words, the tendency will be to leave the stem vowel unchanged. However, the present study differs from Myerson's in that the subjects were given possible outcomes to choose from. They were also instructed to choose a derived word with a different vowel unless changing vowel would result in a word that was completely unacceptable. The nonce items in (1) were

included to test whether the subjects had adopted the strategy of considering possible changes, instead of merely leaving the vowel unchanged.

(1) Nonce words containing [eⁱ, iⁱ, aⁱ, o^w]⁶ in stressed position (n=12).

Example: *denague* > *den_guity*

Possible Responses:

1-No change: *den[eⁱ]guity*.

2-The lax vowel [æ, **g** I, a] predicted by the Spelling Rule: *den[æ]guity*.

3-Another lax vowel as a distractor: *den[ʌ]guity*.

The combined number of responses for all 12 items (Table 1) shows an overwhelming tendency toward the lax vowels predicted by the Spelling Rule over the no change condition and distractor responses ($\chi^2(2)=307.840$, $p < .001$):

++Insert Table 1 here++

The ability of the Spelling Rule to affect nonce words confirms the findings by Wang and Derwing (1994), and those the study by Myerson (1976) in which the no change condition was not an option. At the same time, it demonstrates that the subjects were willing to consider responses with vowels other than those that appeared in the test words. This means that the Surface Analogy did not negate the influence of the Spelling Rule, as may have been the case in the previous studies.

4.4.2. Neologisms with [æ, **g** a, oⁱ, æ^w]. The reason for including these items was to determine the effect that Surface Analogy has on vowel alternations apart from any possible influence due to the Spelling Rule. To this end, nine test items were included whose morphemic relatives

contain vowels not consistent with the Spelling Rule (e.g. [a]~[æ] in *coffee~caffeine*; [ɹ]~[v] in *compel~compulsion, compulsive*). It is important to note that the subjects did not see the morphemic relatives (e.g. *caffeine*) of the test word (e.g. *coffee*).

- (2) Neologisms containing the non-spelling rule vowels [æ, ɹ, ɔ, æ^w] in stressed position (n=9).

Example: *coffee* > *c_ffify*. Related word: *caffeine*.

Possible Responses:

1-No change: *c[a]ffify*.

2-Vowel from related word predicted by Surface Analogy: *c[æ]ffify*.

3-Another lax vowel as a distractor: *c[v]ffify*.

Any preference for the vowel in the morphemic relative would be attributed to Surface Analogy.

A Chi-squared analysis indicates that the distribution of the responses (Table 2) is not random ($\chi^2(2)=55.918, p < .001$). Moreover, responses that favor the vowel of the morphemic relative are significantly more numerous than responses in which the vowel was not changed in the suffixed form ($\chi^2(1)=17.337, p < .001$).

++Insert Table 2 here+

Upon comparing the outcomes of (1) and (2), it appears that the Spelling Rule wielded more influence on the choice of response than Surface Analogy did. This is to be expected. The Spelling Rule generally have their locus in a single letter (or phoneme, Wang, 1985). Therefore, when a subject is asked to choose what vowel sounds most correct when a word containing <a> is suffixed, a number of things could happen. The subject could make conscious use of the fact that [æ] is the 'short' version of [e]. This strategy was reported by several subjects in previous

experiments (Jaeger, 1984; Wang, 1985; Wang and Derwing, 1986).

A less conscious process is also possible. The high incidence of spelling rule alternations among English words could lead to a situation in which [eⁱ] and [æ] are linked associatively in the mind (Wang, 1985). Whenever one is heard or produced, the other is partially activated as well. Reading the letter <a> in certain contexts could activate both [eⁱ] and [æ] at the same time. Regardless of the process, the point is that in order to choose the other member of the spelling rule pair, nothing is needed beyond the graphemic or phonological information about the vowel.

The situation is very different as far as the items in (2) are concerned. There, the extremely common vowel alternations of the Spelling Rule cannot come into play. Instead, the morphemic relatives of the test word are the crucial factor. For example, *coffee* will yield *c[æ]ffify* (definition given in test paragraph: to make taste like coffee) if the word *caffeine* or *caffeinat*e is linked to it in the mental lexicon. This linking allows *caffeine* to be consciously accessed or unconsciously activated. In this manner, its stem vowel is available to be used in the neologism according to Surface Analogy. What this means is that the effect of Surface Analogy is dependent on a subject's having associated the relevant words in the mental lexicon. Exactly what words are associated in memory is more likely to vary from person to person than are the vowels that are associated via the Spelling Rule. This may explain why the results for the items in (2) show less influence when compared with those in (1).

4.4.3. Nonce with [æ, ɔ^j, a, o^j, æ^w]. It is conceivable that the results from the neologisms in (2) are not actually due to Surface Analogy. Instead, the subjects may have perceived some sort of similarity between the vowels in the test words and the vowels of the preferred responses. In

other words, access or activation of the test words' morphemic relatives may not have influenced the outcome. For this reason, these nine nonce items were included as controls for their respective neologisms in (2). Each nonce word is matched to a specific neologism from (2) in terms of the stressed vowel in the unaffixed word, the suffix used in the response, and the vowels in the three responses. Response A corresponds to the 'Vowel in Other Allomorph' response in (2), and Response B corresponds to the 'Distractor Response' in (2):

- (3) Control nonce words containing the non-spelling rule vowels [æ, **g**a, o^j, æ^w] in stressed position (n=9).

Example: *prolot* > *prol_tify*, (matched to *coffee* > *c_ffify* in (1)).

Possible Responses:

1-No change: *prol[a]tify*

2-Another lax vowel as a distractor: *prol[æ]tify*.

3-Another lax vowel as a distractor: *prol[v]tify*.

In Table 3, it is evident that the choice of responses to these nonce items is random ($\chi^2(2)=2.779$, $p < .1$), in clear contrast to the outcome in (2). Therefore, the hypothesis that Surface Analogy is responsible for the results in (2) is further supported.

++Insert Table 3 here++

4.4.4. Neologisms influenced toward the same outcome by the Spelling Rule and Surface Analogy. To this point, the effects of Surface Analogy and the Spelling Rule have been considered separately. Here the additive effects of the Spelling Rule and Surface Analogy are tested. Twelve test items were chosen that contained [e^j, i^j, a^j, o^w, u^w] in stressed position, and

were thus subject to being influenced by the Spelling Rule. In addition, each test word has at least one morphemic relative containing a vowel consistent with the Spelling Rule (e.g. *Palestine, Palestinian*). This allows Surface Analogy to become an influencing factor as well.

- (4) Neologisms containing [eⁱ, iⁱ, aⁱ, o^w, u^w] in stressed position, that also have morphemic relatives with the corresponding lax vowels [æ, **ɪ**, a, ʌ] predicted by the Spelling Rule (n=12).

Example: *intervene* > *interv_natory*. Related word: *intervention*.

Possible Responses:

1-No change: *interv[iⁱ]natory*.

2-Lax vowel [æ, **ɪ**, a, ʌ] predicted by the Spelling Rule and Surface Analogy:
interv[ɪ]natory.

3-Another lax vowel as a distractor: *interv[æ]natory*.

As seen in Table 4, the combination of these two factors results in extremely strong preference for the lax Spelling Rule and Surface Analogy vowels ($\chi^2(2)=527.023, p < .001$):

++Insert table 4 here++

These results are important since previous studies did not consider the influence that morphemic relatives with spelling rule allomorphy can have on the formation of neologisms, in addition to that of the Spelling Rule themselves.

4.4.5. Neologisms influenced toward different outcomes by the Spelling Rule and Surface Analogy. Each of these test words contain the tense vowels associated with the Spelling Rule: [eⁱ, iⁱ, aⁱ, o^w, u^w]. However, none of the words' morphemic relatives demonstrate a vowel change

(e.g. *nude~nudity*):

- (5) Neologisms containing [eⁱ, iⁱ, aⁱ, o^w, u^w] in stressed position, all of whose morphemic relatives contain these same vowels (n=12).

Example: *survive* > *surv_vative*. Related word: *survival*.

Possible Responses:

1-No change predicted by Surface Analogy: *surv[aⁱ]vative*.

2-Lax vowel [æ, **ɒ**, I, a, ʌ] predicted by the Spelling Rule: *surv[I]vative*.

3-Another lax vowel as a distractor: *surv[**ɒ**]vative*.

Words of this sort were tested by Steinberg and Krohn (1975) and Ohala (1974).⁷ They found a strong tendency to leave the vowel unchanged in the suffixed words. According to Surface Analogy, this is due to the influence of the morphemic relatives which contain the same vowel as the test words. Responses to the 12 test words in the present study produced the results in Table 5 ($\chi^2(2) = 135.230, p < .001$):

++Insert Table 5 here++

In contrast to the previous studies, many more subjects preferred responses with a vowel shifted in the direction of the Spelling Rule. However, this is to be expected since the subjects in the present study were provided responses to choose from. In addition, the instructions for the questionnaire put emphasis on making vowel changes any time they sounded correct.

These results may be compared to those of the nonce items in (1). In (1), the effect of the Spelling Rule is strongly manifest, but since nonce items have no morphemic relatives, there was little preference for responses with no vowel change. In the case of these neologisms, however, it is evident that the responses were equally influenced by the Spelling Rule and the test words'

morphemic relatives in accordance with Surface Analogy. Although more responses reflect the influence of the Spelling Rule over that of Surface Analogy, the difference is not significant ($\chi^2(1)=2.430, p < .25$).

One could argue that the tendency toward the no change condition is not actually due to the vowel in the morphemic relatives of the test words, but to the vowel of the test words themselves.⁸ That is, subjects may have preferred the vowel [u^w] in the derived word *nudify*, not because of the influence of related words such as *nudity*, but because of the test word itself--*nude*. This would suggest that the vowels of the words' morphemic relatives were irrelevant. In order to test this, words need to be considered with morphemic relatives whose vowels neither follow the Spelling Rule nor are the same as the test words' vowels. The next section discusses test words of this type.

4.4.6. Other neologisms influenced toward different outcomes by the Spelling Rule and Surface Analogy. Each of these test words contain the tense vowels associated with the Spelling Rule: [eⁱ, iⁱ, aⁱ, o^w, u^w]. However, the words' morphemic relatives demonstrate a vowel change not consistent the Spelling Rule (e.g. *peace*, *pacify*):

- (6) Neologisms containing [eⁱ, iⁱ, aⁱ, o^w, u^w] in stressed position, whose morphemic relatives contain vowels not predicted by the Spelling Rule (n=9).

Example: *abstain* > *abst_natory*. Related word: *abstention*.

Possible Responses:

1-No change in the vowel: *abst[eⁱ]natory*.

2-Vowel from related word predicted by Surface Analogy: *abst[ɔ]natory*.

3-Lax vowel [æ, ɒ, ɪ, a, ʌ] predicted by the Spelling Rule: *abst[æ]natory*.

The influence of both the Spelling Rule and the vowel of the morphemic relatives are evident in Table 6 ($\chi^2(2)=84.356, p < .001$). However, the influence wielded by the Spelling Rule is somewhat stronger than that of Surface Analogy when the number of responses in the two categories are compared ($\chi^2(1)=7.410, p < .01$). Had the vowel of the test word itself influenced the subjects responses, the no change response would have been preferred more often.

++Insert Table 6 here+

Although the influence of the Spelling Rule is stronger than that of Surface Analogy, many responses that reflected Surface Analogy were still chosen. If one were to consider Surface Analogy and the Spelling Rule as constraints in Optimality Theory, one would have to conclude that there is no single unique constraint ranking between the two; the stronger influence of the Spelling Rule in the present study is not motivation enough to place the Spelling Rule in a position of dominance over Surface Analogy in all cases since the subjects appear to have been influenced by both factors.

There is a factor that needs to be mentioned which may have influenced the results reported in this section. There are very few words containing the tense vowels associated with the Spelling Rule that have morphemic relatives with vowels not consistent with the Spelling Rule. Those that do exist generally have alternate spellings of the crucial vowel in question (e.g. *abstain~abstention, peace~pacify*). Although the response choices were given to the subjects auditorally, and not in writing, the subjects did see an orthographic representation of the base forms (e.g. *abstain, peace*) in the test paragraphs. The basic idea behind Spelling Rule influence is not only that two different vowel sounds alternate in morphologically related words, but that

they are generally represented with the same written vowel. Therefore, it is impossible to eliminate orthography as a confounding factor for the test items in this section.

5. Conclusions. The purpose of the experiment was to determine the extent to which Spelling Rule and Surface Analogy affect the formation of neologisms and nonce words. This is not to discount the possibility that other factors, which were not considered, may have played a part. For example, words which bear orthographic, phonetic, or semantic similarities to the test words may have affected the outcome. The present study did not attempt to control for these variables.

Nevertheless, the findings of this experiment clearly indicate that the vocalic alternations embodied in the English spelling rules affected the subjects' vowel preferences in derived neologisms and nonce words. Furthermore, the vowels in morphemic relatives of the test words also influenced the subjects' preferences in accordance with surface analogy. The strongest preference for Spelling Rule shifts occurred in the neologisms in (4). There, the tense vowels associated with the Spelling Rule existed in the test words, which made the alternation with the lax vowels of the Spelling Rule possible. At the same time, these test words all had morphemic relatives with the lax vowels of the Spelling Rule. Therefore, the vowel shift in the derived form of the test words was approved of by Surface Analogy (e.g. *senile* > *sen[ɪ]lify*, morphemic relative: *senility*). The items in (2) demonstrate how non-Spelling Rule vowel shifts can be induced under the influence of morphemic relatives (e.g. *astound* > *ast[a]ndatory*, morphemic relative: *astonish*). This effect, however, is less robust than that of the Spelling Rule.

In some cases, the Spelling Rule and Surface Analogy are at odds with each other. The Spelling Rule work to shift certain tense vowels into their corresponding lax varieties in the

derived words. Surface Analogy, on the other hand, disfavors these shifts unless a morphemic relative of the test word exists which contains the corresponding lax vowel. For example, the almost complete absence of Spelling Rule shifts in the production tests by Myerson (1976), Ohala (1974), and Steinberg and Krohn (1975) is due to Surface Analogy; no morphemic relatives of the test words exist with a Spelling Rule shifted vowel. However, in the present study, a significant number of Spelling Rule shifts occurred in (1), (5), and (6) in spite of the fact that none of the test items had morphemic relatives with Spelling Rule vowel changes. This was also the case in the preference study by Myerson (1976) and the experiments by Wang and Derwing (1994). In all of these studies, the effects of the Spelling Rule were allowed to override Surface Analogy because the experimental methodology placed emphasis on making vowel changes. In Myerson's and Wang and Derwing's studies, subjects were forced to produce a vowel change, and the no change condition was not an option. In the present study, responses with no change were available, but the instructions focused the subjects' attention on making vowel changes wherever they felt it was possible.

Perhaps the most interesting items are those in (5) and (6) where the effects of the Spelling Rule and Surface Analogy are not additive as in (4), but contrastive. That is, the Spelling Rule and Surface Analogy influenced the vowels of the test items to shift in different directions. In both cases, test items contained the tense vowels associated with the Spelling Rule. However in (5), none of the morphemic relatives contained a shifted vowel (e.g. *adhere*, morphemic relatives: *adhesion*, *adherence*). In these cases, there were roughly the same number of responses containing no change in the vowel, as Surface Analogy would predict (e.g. *adh[ɪ]satory*), as there were responses reflecting the influence of the Spelling Rule

(e.g. *adh[ɟsatory]*). In (6), the morphemic relatives of the test words demonstrate a vowel shift, but not in the direction of the Spelling Rule (e.g. *domain*, morphemic relatives: *dominion*). The influence of the Spelling Rule in these forms is stronger than that of the vowel in the morphemic relatives. However, preferences consistent with both influences were obtained (e.g. *dom[æ]nic*, *dom[I]nic*).

In short, these findings provide evidence that the formation of novel words can be influenced both by the Spelling Rule and the word's morphemic relatives per Surface Analogy. The psychological reality of the Spelling Rule alternations has already received a great deal of support. However, the finding that non-Spelling Rule alternations also play a part in the subjects' preferences is novel.⁹ The fact that the morphemic relatives of the test words influenced the subjects' preferences lends further support to models in which all morphologically related words have fully specified individual representation in the mental lexicon and are available to exert analogical influence on related forms.

Notes

1. It is possible that some other two letter sequences that represent the same alternation also participate in the spelling rules (e.g. *deep~depth, brief~brevity, youth~young*).
2. The Rumelhart and McClelland model has received a great deal of criticism (Lachter and Bever 1988; Pinker and Prince 1988). However, the validity of the connectionist approach does not rest on Rumelhart's and McClelland's model. Several other connectionist models have been developed which address the criticisms of Rumelhart's and McClelland's model (Cottrell and Plunkett 1991; MacWhinney and Leinbach 1991; Plunkett and Marchman 1991) and argue for the viability of the connectionist approach.
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4. I am thankful to one reviewer for noting that *demonstrable* is actually an attested word, not a neologism.
5. The experimenter has an American English dialect which lacks the phoneme /ɹ/.
6. No items with [u^w] were included, since the alternation [u^w~v] occurs in the fewest number of English words, and is the weakest of the alternations in the spelling rule. Wang (1985) suggests that the vowels in this alternation have not developed strong phonological links to each other as the other spelling rule alternations have.
7. Incidentally, Ohala was able to provoke more shifts if the subjects were shown words pairs demonstrating a vowel shift on which to model their response.
8. It may be the case that both the vowel of the test word, and that of the morphemic relative both exert an influence on the response.
9. Four test items support the alternations [æw]~[v], [æw]~[a], and [ɹy]~[a] in that the subjects

preferred these alternations to the no change condition or to the response with other lax vowel:

pronounce > *pron*[v]*nciatory*; *renounce* > *ren*[v]*nciatory*; *astound* > *ast*[a]*ndatory*; *voice* >

v[a]*cify*. This contradicts previous studies on the vowel shift which found that these alternations

were not significant (Jaeger 1984; Wang and Derwing 1986).

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Appendix

Stimulus Materials

(1) Nonce words with [eⁱ, iⁱ, aⁱ, o^w] (Some taken from Wang 1985)

obtíce + atory

retróne + tion

denágue + ity

extáce + ify

purtóse + ify

condíte + ify

subguéte + ative

depíde + ical

conléce + ical

envápe + ity

connófe + itory

surféne + ified

(2) Neologisms with [æ, **g** a, oⁱ, æ^w]

Test Word

compell + ative

example + ical

coffee + ify

Related Word

compulsive

exemplary

caffeine

renounce + iatory

renunciation

pronounce + iatory

pronunciation

voice + ify

vocal

propel + ative

propulsion

impel + atory

impulse

astound + atory

astonish

(3) Nonce words with [æ, **g** a, o^l, æ^w] (Some taken from Wang 1985)

disnáque + ity

prolót + ify

encóuce + iatory

pertóice + ify

exdém + atory

subnél + ative

extóuze + atory

defóuce + iatory

purvéss + ative

(4) Neologisms containing [e^l, i^l, a^l, o^w, u^w] with [æ, ɒ, ɪ, a, ʌ] in other allomorphs in accordance with the spelling rule.

| <u>Test Word</u> | <u>Related Word</u> |
|--------------------------|---------------------|
| <i>serene + ifying</i> | <i>serenity</i> |
| <i>intervene + atory</i> | <i>intervention</i> |
| <i>revise + atory</i> | <i>revision</i> |
| <i>cave + cal</i> | <i>cavern</i> |
| <i>senile + ify</i> | <i>senility</i> |
| <i>preside + ative</i> | <i>president</i> |
| <i>Palestine + ify</i> | <i>Palestinian</i> |
| <i>harmonious + ity</i> | <i>harmonic</i> |
| <i>insane + ify</i> | <i>insanity</i> |
| <i>cone + ify</i> | <i>conical</i> |
| <i>line + ify</i> | <i>linear</i> |
| <i>vain + ifying</i> | <i>vanity</i> |

(5) Neologisms with [e^l, i^l, a^l, o^w, u^w] with the same vowels in all morphemic relatives

| <u>Test Word</u> | <u>Related Word</u> |
|------------------------|---------------------|
| <i>pirate + ified</i> | <i>piratical</i> |
| <i>stupid + ical</i> | <i>stupidity</i> |
| <i>survive + ative</i> | <i>survival</i> |
| <i>nude + ify</i> | <i>nudity</i> |

| | |
|----------------------------|-------------------|
| <i>obtain + atory</i> | <i>obtainment</i> |
| <i>adhesion + atory</i> | <i>adhere</i> |
| <i>anecdote + ify</i> | <i>anecdotal</i> |
| <i>chrome + ify</i> | <i>chromic</i> |
| <i>obese + ify</i> | <i>obesity</i> |
| <i>microbe + ification</i> | <i>microbial</i> |
| <i>fame + ify</i> | <i>famous</i> |
| <i>scene + ify</i> | <i>scenic</i> |

(6) Neologisms with [e^j, i^j, a^j, o^w, u^w] whose morphemic relatives lack [æ, ɹ, a, ʌ]

| <u>Test Word</u> | <u>Related Word</u> |
|------------------------|---------------------|
| <i>abstain + atory</i> | <i>abstention</i> |
| <i>domain + ic</i> | <i>dominion</i> |
| <i>peace + ical</i> | <i>pacify</i> |
| <i>nose + ifying</i> | <i>nasal</i> |
| <i>pride + ical</i> | <i>proud</i> |
| <i>bind + ative</i> | <i>bond</i> |
| <i>detain + atory</i> | <i>detention</i> |
| <i>pertain + atory</i> | <i>pertinent</i> |
| <i>sustain + atory</i> | <i>sustenance</i> |

| No Change | Spelling Rule Response | Distractor Response |
|------------------|-------------------------------|----------------------------|
| 53 | 346 | 93 |

Table 1. Nonce words with stressed Spelling Rule vowels.

| No Change | Vowel in Other Allomorph | Distractor Response |
|------------------|---------------------------------|----------------------------|
| 113 | 186 | 70 |

Table 2. Neologisms with stressed non-Spelling Rule vowels and morphemic relatives with non-Spelling Rule vowels.

| No Change | Response A | Response B |
|------------------|-------------------|-------------------|
| 132 | 129 | 108 |

Table 3. Nonce words with stressed non-Spelling Rule vowels and same response option vowels as in (2).

| No Change | Spelling Rule and Surface Analogy Response | Distractor Response |
|------------------|---|----------------------------|
| 48 | 404 | 40 |

Table 4. Neologisms with stressed Spelling Rule vowels and morphemic relatives with the corresponding lax Spelling Rule vowels.

| No Change per Surface | Spelling Rule Response | Distractor Response |
|-----------------------|------------------------|---------------------|
| Analogy | | |
| 207 | 241 | 44 |

Table 5. Neologisms with stressed Spelling Rule vowels, all of whose morphemic relatives contain these same vowels.

| No Change | Spelling Rule Response | Surface Analogy Response |
|------------------|-------------------------------|---------------------------------|
| 45 | 187 | 137 |

Table 6. Neologisms with stressed Spelling Rule vowels, whose morphemic relatives have non-Spelling Rule lax vowels.

1. It is possible that some other two letter sequences that represent the same alternation also participate in the spelling rules (e.g. *deep~depth, brief~brevity, youth~young*).
2. The Rumelhart and McClelland model has received a great deal of criticism (Lachter and Bever 1988; Pinker and Prince 1988). However, the validity of the connectionist approach does not rest on Rumelhart's and McClelland's model. Several other connectionist models have been developed which address the criticisms of Rumelhart's and McClelland's model (Cottrell and Plunkett 1991; MacWhinney and Leinbach 1991; Plunkett and Marchman 1991) and argue for the viability of the connectionist approach.
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9. Four test items support the alternations [æw]~[v], [æw]~[a], and [ɹy]~[a] in that the subjects preferred these alternations to the no change condition or to the response with other lax vowel: *pronounce* > *pron[v]nciatory*; *renounce* > *ren[v]nciatory*; *astound* > *ast[a]ndatory*; *voice* > *v[a]cify*. This contradicts previous studies on the vowel shift which found that these alternations were not significant (Jaeger 1984; Wang and Derwing 1986).